IN THE MATTER OF
KOREAN PATENT APPLICATION
UNDER SERIAL NO. 10-2002-0067669

I, THE UNDERSIGNED, HEREBY DECLARE :
THAT I AM CONVERSANT WITH BOTH THE KOREAN AND THE ENGLISH LANGUAGES : AND

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IN THE NAME OF: LG ELECTRONICS INC.

FOR: EARLY SYNCROUNIZATION SEARCH METHOD FOR MOBILE COMMUNICATION SYSTEM

IN WITNESS WHEREOF, I SET MY HAND HERETO

THIS 8th DAY OF JUNE, 2007

BY 

LEE, Shin Sook

[Translation]

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Applicant : LG ELECTRONICS INC.
Code No. : 1-2002-012840-3

Attorney : Names : PARK, Jang Won
Code No. : 9-1998-000202-3
General Authorization registration No.: 2002-027075-8

Inventor : Name : LEE, Jae Cheol
Resident Reg. No.: 710305-1068127
Zip code : 156-772
Address: Kukdong Apt. 106-401, Sadang 2-Dong, Dongjak-Gu, Seoul, Korea
Nationality : Republic of Korea

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This application is hereby filed pursuant to Article 42 and request for examination is filed pursuant to Article 60 of the Patent Law, respectively.

/S/ Attorney : PARK, Jang Won

[SPECIFICATION]

[Title of the Invention]

INITIAL SYNCHRONIZATION SEARCHING APPARATUS AND METHOD OF MOBILE COMMUNICATION SYSTEM

[Brief description of the Drawings]

FIG. 1 is an exemplary view showing a frame form of a physical channel in a TD-SCDMA (Time Division-Synchronous Code Division Multiple Access) for mobile or a UMTS-TDD; a

FIG. 2 is a flow chart illustrating the processes of a method for searching an initial synchronization searching method of a mobile communication system according to the present invention; and

FIG. 3 is an exemplary view of energy distribution of a signal obtained in FIG. 2.

[Detailed description of the invention]

[Object of the invention]

[Field of the invention and background art]

The present invention relates to an initial synchronization searching method of a mobile communication system and, more particularly, to an initial synchronization searching method of a mobile communication system capable of obtaining a forward synchronization with a base station by searching a forward pilot time slot with a smaller amount of calculation during an initial cell searching process of TD-SCDMA (Time Division-Synchronous Code Division Multiple

Access) for mobile (TSM) communication system.

The TSM communication system is a communication system combining an NB-TDD (Narrow Band Time Division Duplexing) CDMA communication system and a GSM (Global System for Mobile Communications) system. In the TD-SCDMA communication system, a radio interface, a first layer (Layer 1) between a terminal (mobile station) and a base station is the same as the NB-TDD CDMA system and the other upper layers have the same structure as the GSM system.

First, an initial cell searching process of the TSM communication system will now be described.

The initial cell searching process of the TSM communication system is divided into four steps: first step is to receive base station information of a cell to which a terminal belongs currently; a second step is to identify a scrambling code and a basic midamble code being used; a third step is to check a position of a broadcast control channel (BCCH); and a fourth step is to access information on a common channel including information, that is, system information, transferred through the BCCH.

In step of receiving information on a base station to which the terminal belongs, the terminal searches a downlink pilot time slot (DwPTS) in order to obtain downlink synchronization with the base station. The terminal searches the DwPTS by using a synchronous (SYNC) code, and the terminal uses one or two or more matching filters. Here, the terminal should recognize which SYNC code it will use among the pre-set 32 SYNC codes.

In obtaining corrrelation with respect to an inputted signal, a 64-tap FIR filter, the length of the downlink pilot, is used. In this case, the pilot includes 32

types of signals, so implementation of 32 65-tap filters would allow finding of initial synchronization at the fastest speed, but its hardware would be too complicated.

If a device for searching initial synchronization is implemented with a single filter, it would repeatedly perform the operation 32 times to find a maximum value.

In terms of implementation of software, when the filter tap is long, it means a large number of multiplications and additions are performed repeatedly. Namely, a single correlator should perform 64 times of multiplications and additions, which is to be performed 32 times for every input signal I(t) and Q(t).

Thus, unless a calculation speed is faster than a speed of an input signal because a calculation speed is not sufficient, a signal more than 1 sub-frame should be stored in a memory and then the calculation operation should be repeatedly performed by 32 times.

The reduction in the amount of calculation of a moving device is closely related to power consumption, so the best method needs to be selected.

[Problem to be solved by the invention]

Therefore, an object of the present invention is to provide an initial synchronization searching method of a mobile communication system capable of simply processing initial synchronization searching of a mobile communication system by searching a candidate region where a synchronous code can be positioned with a smaller amount of calculation and performing correlation only on some samples without having to perform correlation on the entire input signal.

[Construction of the invention]

To achieve these and other advantages, there is provided an initial synchronization searching method of a mobile communication system including: sampling a baseband signal, sequentially adding it to an accumulation buffer corresponding to I and Q signals, and repeatedly performing adding starting again from the first of the accumulation buffer when it reaches the end of the accumulation buffer; taking an absolute value of values stored in the accumulation buffer, adding value of the I and Q accumulation buffers, and allowing passing of a low pass filter; estimating a candidate region of a downlink pilot time slot in an energy distribution of the signal which has passed through the low pass filter, and searching the most similar downlink synchronous code in the candidate region.

The preferred embodiment of the present invention will now be described in detail with reference to the accompanying drawings.

In general, a pilot signal of the TD-SCDMA mode or a UMTS-TDD (Universal Mobile Telecommunications System-Time division Duplexing) mode has a characteristic that it is repeated at a specific position of every sub-frame. In contrast, other signals are expressed as random signals. This is requisite in terms of the CDMA.

In the present invention, buffers for storing I(t) and Q(t) signals are provided, in which input signals are accumulated for several frames. In this case, only addition is necessarily performed for a single sample.

After a certain frame time elapses, an absolute value of the accumulation values of the input signals stored in the buffers is taken and passed through a low pass filter. Then, only a periodical signal is remarkable at a sub-frame among

average power of the signals. Thus, assuming that the buffers are the circulation buffers, a remarkable signal region exceeding a certain length (about 60 chips) is searched and selected as a candidate region, and a correlation is performed on the selected candidate region.

In this method, because only addition is performed one time on the entire input signals, the calculation is very simple. In addition, because the candidate region can be estimated very precisely, there are not many follow-up calculations, and especially, because the processing is not performed in parallel, a software implementation, as well as hardware, is quite easy.

In an appendix B-1 of 3GPP TS 25.233, 32 synchronous codes (Sync-DL) having 64 bits are shown. The base station selects one of them and repeatedly inserts it in a particular portion of every sub-frame, so that the terminal can use it in performing an initial synchronization. This is the first step of the cell searching process described in an appendix D of the 3GPP TS 25.224.

FIG. 1 shows the form of a physical channel of the UMTS-TDD 1.28Mcps. Here, the shadowed regions are where DwPTS (Downlink Pilot Time Slot) are positioned, and the other remaining regions are used as data and control channels. There is a possibility that a UpPTS (Uplink Pilot Time Slot) that transmitted by other terminals nearby is received. In addition, noise and signals which have passed through a fading channel are received. A terminal should fine the position of the DwPTS by selecting a signal with the most excellent correlation characteristics from the 32 synchronous codes.

FIG. 2 is a flow chart illustrating the processes of a method for searching an initial synchronization searching method of a mobile communication system according to the present invention. As shown in FIG. 2, the initial synchronization

searching method of a mobile communication system according to the present invention includes: sampling a baseband signal, sequentially adding it to an accumulation buffer corresponding to I and Q signals, and repeatedly performing adding starting again from the first of the accumulation buffer when it reaches the end of the accumulation buffer; taking an absolute value of values stored in the accumulation buffer, adding value of the I and Q accumulation buffers, and allowing passing of a low pass filter; estimating a candidate region of a downlink pilot time slot in an energy distribution of the signal which has passed through the low pass filter, and searching the most similar downlink synchronous code in the candidate region.

If the terminal performs over-sampling on the baseband signal by m times of a chip rate of I(t) and Q(t), integer memory buffers of 6,400*m*2 are prepared. The buffers are initialized as 0. The inputted I(t) and Q(t) signals are sequentially added to the buffers.

When it reaches the end of the buffers, the addition is repeatedly performed starting from the start portion of the buffers. Here, the baseband signals are stored in the accumulation buffers by using equation shown below:

[Equation 1]

$$I(t)\,accumulation\,buffer = \sum I(t\%L),\ Q(t)\,accumulation\,buffer = \sum Q(t\%L)$$

wherein 'L' is 6,400xm, % is the remnant operator, and Σ indicates the sum of values having the same (t%L).

When the process is finished, assuming that a noise signal has zero-mean characteristics and UpPTSs between time slots (TS0-TS6) and different terminals are uncorrelated in the TD-SCDMA physical channel, the addition value can become close to a kind of zero-mean random noise. Then, only power of the

DwPTS can appear remarkably. And in order to make such characteristics more certain and in order to search a desired position candidate, an absolute value is taken, values of the I(t) buffer and the Q(t) buffer are added to have a size of 6,400*m, which is then passed through the low pass filter. Herein, obtaining of the absolute of the accumulation buffer and adding of the values of the I(t) and Q(t) accumulation buffers are performed according to equation (2) shown below:

[Equation 2]

$$\left|\sum I(t\%L)\right| + \left|\sum Q(t\%L)\right|$$

wherein 'L' is 6,400xm, % is the remnant operator, and $\sum$ indicates the sum with respect to values having the same (t%L).

FIG. 3 is an exemplary view of energy distribution of a signal obtained in FIG. 2. Here, an energy block having a similar length as that of 64 chips can be considered as position of DwPTS and in this case the width (W) is a search range for obtaining an accurate position. FIG. 3b shows a case where energy generated by a single terminal nearby appears in UpPTS. In this case, it can appear with energy greater than DwPTS, but if the length of energy corresponds to 128 chips, it should not be included as the candidate region of DwPTS. The position of UpPTS is relatively fixed like in FIG. 1, it helps to estimate the position of DwPTS.

In the present invention, the complicate calculation required for the initial synchronization of the UMTS-TDD 1.28Mcps terminal can be considerably reduced. That is, the use of the system can have a gain that the search range of the synchronous code is reduced by the width (W) from the overall search range 6,400*m, but an overhead extending through S11 to S14 is required. However, the calculation amount of overhead can be designed to be quite small compared

with the gain of reducing the search range.

Thereafter, the most similar forward synchronous code in the candidate region of DwPTS is searched.

[Effect of the invention]

As so far described, in the present invention, although the terminal performs only addition instead of multiplication and addition required for obtaining synchronization with the base station, it performs the initial synchronization search, the overall calculation amount can be reduced, so the complexity can be reduced in implementing the system and the power consumption is reduced.

[Translation]

ABSTRACT OF THE DISCLOSURE

[Abstract]

An initial synchronization searching method of a mobile communication system is disclosed. In the related art, multiplication and addition are repeatedly performed for a correlation operation performed for obtaining an initial synchronization, causing a problem that the system complexity increases and power consumption is also increased due to the large amount of calculation. The initial synchronization searching method of a mobile communication includes: sampling a baseband signal, sequentially adding it to an accumulation buffer corresponding to I and Q signals, and repeatedly performing adding starting again from the first of the accumulation buffer when it reaches the end of the accumulation buffer; taking an absolute value of values stored in the accumulation buffer, adding value of the I and Q accumulation buffers, and allowing passing of a low pass filter; estimating a candidate region of a downlink pilot time slot in an energy distribution of the signal which has passed through the low pass filter, and searching the most similar downlink synchronous code in the candidate region.

[Representative drawing]

FIG. 2

What is claimed is:

1. An initial synchronization searching method of a mobile communication system comprising:

sampling a baseband signal, sequentially adding it to an accumulation buffer corresponding to I and Q signals, and repeatedly performing adding starting again from the first of the accumulation buffer when it reaches the end of the accumulation buffer; taking an absolute value of values stored in the accumulation buffer, adding value of the I and Q accumulation buffers, and allowing passing of a low pass filter; estimating a candidate region of a downlink pilot time slot in an energy distribution of the signal which has passed through the low pass filter, and searching the most similar downlink synchronous code in the candidate region.

2. The method of claim 1, the absolute value calculation and addition of the accumulation buffers are performed according to equation shown below:

$$\left|\sum I(t\%L)\right| + \left|\sum Q(t\%L)\right|$$

wherein 'L' is 6,400xm, % is the remnant operator, and Σ indicates the sum with respect to values having the same (t%L).

FIG.1

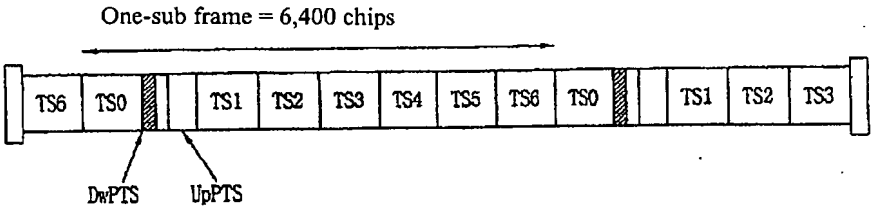

FIG.2

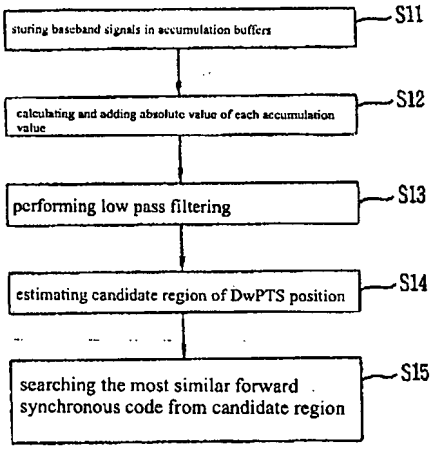

FIG.3